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# Correlates of Lifetime and Past Month Vape Use in a Sample of Canadian University Students

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## ABSTRACT

**INTRODUCTION:** This study examines correlates of lifetime (ie, ever vaped) and past month vape use among students aged 17 to 19 years, 20 to 25 years, and 26+ years from Western University in London, Ontario. The secondary objective is to assess lifetime and past month vape use among students not of legal age to purchase vaping products in Ontario (ie, those 17 to 18 years only).

**METHODS:** Using Qualtrics, a cross-sectional survey was sent via email to all students at Western University (N = 38 442), assessing their current and past risk-taking behaviors, mental health, sociodemographic characteristics, as well as questions pertaining to their family structure and socioeconomic background during childhood. Students were asked if they had ever vaped in their lifetime and about past month vape use. Logistic regression models were used to assess correlates of lifetime and past month vape use.

**RESULTS:** The sample consisted of 2626 university students. Compared to those ages 26+ years, teenage university students were 10 times more likely to have vaped in the past month and males were twice as likely as females to have vaped. Alcohol use doubled the odds of vaping in the past month, whereas cigarette, cannabis, or cocaine use approximately tripled the odds. Students who reported many sexual partners were far more likely to have vaped in the past month.

**CONCLUSION:** Vape use is more common among teenage university students, males, those who drink alcohol, smoke, use cannabis or cocaine, and who report many sexual partners.

**KEYWORDS:** Vaping, risk-taking, students, mental health, social class, e-cigarette vapor, electronic nicotine delivery systems, epidemiology

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## Introduction

Vapes, also known as electronic cigarettes, e-cigarettes, or electronic nicotine delivery systems (ENDS), are handheld battery-operated products that heat liquid and deliver doses of nicotine through an inhalable aerosol.<sup>1</sup> Due to large-scale marketing, the popularity of vaping has increased in recent years among all age groups, and in particular among adolescent and youth populations.<sup>2</sup> In 2019, 23% of students in grades 7 to 12 in the Canadian province of Ontario had vaped in the past year and 13% reported weekly or daily use.<sup>3</sup> Similarly, evidence from colleges in the U.S. has shown a correlation between vape advertising and use, as many colleges are located within close proximity to vape retailers.<sup>4,5</sup>

The transition from high school to college or university is a major life transition that leaves students vulnerable to greater risk-taking behavior.<sup>6,7</sup> Much of this is attributable to more individual autonomy, less parental control, and exposure to a new

environment with different social groups, all of which can lead to psychological distress.<sup>8,9</sup> Data on vape use among post-secondary students in Canada is lacking, as most of this research comes from the U.S. or Europe. In the U.S., the prevalence of lifetime vape use in college students ranges from 27% to 45%, with male gender and cigarette smoking being the most common predictors of vaping<sup>10-12</sup>; in Europe, 23% to 31% of college students have ever vaped, with cigarettes being the most common predictor.<sup>13,14</sup> Many young adults are also experimenting with vape products who have never smoked tobacco. In fact, 40% of current vape users aged 18 to 24 years in the U.S. had never smoked cigarettes<sup>15</sup> and vape use more than doubles the risk of being willing to try cigarette smoking among youth aged 18 to 29 years.<sup>16</sup> Moreover, a meta-analysis of 17 studies found that vape use in non-smoking young people (up to the age of 30 years) was associated with 4.5 times increase in subsequent smoking,<sup>17</sup> suggesting that vape use increases the risk of nicotine addiction.



Timely Canadian research on vape use is needed given its rapidly changing regulatory landscape. For example, although e-cigarettes have been commercially available in the U.S. for over a decade, it was not until May 2018 that Canada approved nicotine-containing e-cigarettes for sale or promotion.<sup>18</sup> As well, from 2017 to 2019, past month vape use in teenagers increased more rapidly in Canada and the U.S. than it did in Europe, and the increase in exposure to vape advertisements in retail environments since 2018 in Canada likely contributed to this increase.<sup>19</sup> Most recently, as of January 1, 2020, the Government of Ontario banned vape advertising by retailers (apart from vape and cannabis specialty shops) in attempt to reduce youth exposure to vape advertising. New evidence suggests that this ban has substantially reduced vaping promotions, as well as socio-demographic inequalities in youth exposure to marketing of vape products.<sup>18</sup>

Given the scarcity of data on vape use in post-secondary students in Canada, the current study has 2 main objectives. The primary objective is to examine correlates of lifetime (ie, ever vaped) and past month vape use among students aged 17 to 19 years, 20 to 25 years, and 26+ years from Western University in London, Ontario. The secondary objective is to assess lifetime and past month vape use among university students who are not of legal age to purchase vaping products in Ontario (ie, those 17-18 years only).

## Methods

Using the secure online platform Qualtrics, an original survey was sent via email in January 2020 to all registered students at Western University, assessing their current and past risk-taking behaviors, mental health, sociodemographic characteristics, as well as questions pertaining to their family structure and socio-economic background during childhood. Two additional biweekly email reminders were sent thereafter, with the last email also being sent to students registered at the Western University affiliated colleges, namely Brescia University College, Huron University College, and King's University College. In total, 38442 students were invited to participate in this cross-sectional survey. As an incentive to complete the survey, students were invited to participate in a draw for 1 of 15, \$50 gift cards to an international bookstore chain. Prior to administration of the online survey, the survey was pretested for content, wording, and question difficulty with a diverse group of students ( $n = 10$ ).

The survey consisted of 50 questions, most of which were closed-ended, and took approximately 10 minutes to complete. Of special interest for the current study were 2 questions related to vape use. The first question asked students if they had ever vaped in their lifetime (yes/no). The second question asked about vaping frequency over the past month. Specifically, students were asked on a 7-point scale the number of days they had vaped over the past month, with response categories as follows: 0, 1 to 2, 3 to 5, 6 to 9, 10 to 19, 20 to 29, and 30 days. Given that 88% of the sample had reported no past month vape use, this variable was dichotomized into past month vape use (yes/no). For a full list of study variables, see Table 1.

The rationale for comparing the 3 age categories of university students (ie, 17-19 years, 20-25 years, and 26+ years) were as follows. Teenage vape use is rapidly becoming a public health crisis and has recently been called a "teen vaping epidemic,"<sup>20</sup> thus comparing the youngest university students (ages 17-19) to older age groups allowed for a direct comparison to other young adults. It also provided an opportunity to conduct a sub-analysis among the youngest teenagers (ie, 17-18 years) who are not of legal age to purchase vaping products in the province of Ontario. While teenage vape use could have been compared to all other ages of university students, the 20 to 25 age category allowed for another youth comparator group, while the 26+ years were considered the oldest grouping of university students. In fact, it is against the law for a vaping retailer to sell or supply a vapor product to a person who appears under the age of 25 in Ontario without asking for proof of identification.<sup>21</sup>

The study received approval from the Non-Medical Research Ethics Board at Western University (#115013).

## Statistical analysis

Data were analyzed using SPSS version 27.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp.). Continuous variables were summarized using the mean and standard deviation (SD) and percentages were used to summarize categorical variables. One-way analysis of variance (ANOVA) compared differences in means between the 3 age groups and the chi-square test compared differences in proportions.

Logistic regression models were used to assess correlates of lifetime and past month vape use. To increase the likelihood that all relevant variables were included in the multivariate analysis, variables that had a bivariate correlation with the 2 outcomes at the  $P < .10$  level were subsequently included in the logistic regressions. The following variables were unrelated to the 2 vaping outcomes for the full sample of university students and thus were excluded from the regression analyses: sexual orientation, childhood family structure, whether students were following a specific diet, and hours of moderate to vigorous physical activity per week. Similarly, religion, sexual orientation, childhood family structure, maternal education, LSD use, whether students were following a specific diet, mental health diagnosis, current living arrangement, and sleep duration were not associated with vape use in the subsample of students ages 17 to 18 years, and thus these variables were excluded from the regression analyses.

The following variables were included in our logistic regression models assessing lifetime and past month vape use for the full sample: age, gender, race/ethnicity, religion, maternal educational attainment, alcohol, cigarette, cannabis, cocaine, LSD, and prescription drug use, number of sexual partners, diagnosed mental illness, self-harm, current living arrangement, and sleep duration per night. For our secondary objective assessing correlates of vape use among those who are not of legal age to purchase vape products in Ontario, the

**Table 1.** Definition and measurement of the study variables.

VARIABLES	MEASUREMENT
Gender	Male (1); Female (2); Self-identify (3)
Age	17-19 years (1); 20-25 years (2); 26+ years (3)
Race	White (1); Non-white (0)
Religion during childhood and presently	Christian (1); Catholic (2); Hindu (3); Islam (4); Sikh (5); No religion (6); Other (7)
Sexual orientation	Straight (1); Gay (2); Lesbian (3); Bisexual (4); Asexual (5); Other (6)
Current living arrangement	Campus (1); Off-campus alone (2); Off-campus with roommates (3); Off-campus with parents (4); Off-campus with common law partner/spouse (5)
Family structure during childhood	Single-parent (1); Two-parent (2); Step/blended (3); Other (4)
Maternal educational attainment	Some high school (1); High school diploma (2); Some college/university (3); College diploma/university degree (4); Postgraduate degree (5)
Following a specific diet	Yes (1); No (2)
Lifetime and past month alcohol use	Yes (1); No (2)
Lifetime and past month cigarette use	Yes (1); No (2)
Lifetime and past month alcohol use	Yes (1); No (2)
Lifetime and past month cannabis use	Yes (1); No (2)
Lifetime and past month cocaine use	Yes (1); No (2)
Lifetime and past month LSD use	Yes (1); No (2)
Lifetime and past month prescription drugs	Yes (1); No (2)
Lifetime and past month vape use	Yes (1); No (2)
Lifetime number of sexual partners	0 (1); 1-5 (2); 6-10 (3); 11-15 (4); 16+ (5)
Ever diagnosed mental health condition	Yes (1); No (2)
Ever engaged in self-harm	Yes (1); No (2)
Hours of sleep per night	5-16 (min, max)
Hours of moderate/vigorous physical activity per week	0 (1); 1-2 (2); 3-4 (3); 5-6 (4); 7-8 (5); 8+ (6)

following independent variables were included: gender, race/ethnicity, family structure, alcohol, cigarette, cannabis, cocaine, and prescription drug use, number of sexual partners, and self-harm.

Since logistic regression is sensitive to high correlations among the independent variables, multicollinearity was assessed by including the same variables used in the logistic regressions in multiple linear regressions to obtain collinearity diagnostics (ie, Tolerance statistic, Variance inflation factor). For the full sample of university students, the Tolerance statistic ranged from a low of 0.70 (VIF=1.44) to a high of 0.97 (VIF=1.03); for the subsample of students ages 17 to 18 years, Tolerance ranged from 0.69 (VIF=1.44) to 0.96 (VIF=1.04), thus indicating no concerns about collinearity. As there were very little to no missing data for all variables, any data that were missing were excluded in our regression models through list-wise deletion.<sup>22</sup> Both crude and adjusted odds ratios (ORs)

with 95% confidence intervals (CIs) are provided in the regression models and the predictive capacity of the models were determined through the Nagelkerke  $R^2$ . A  $P$ -value  $<.05$  was considered statistically significant.

Based on the work of Peduzzi et al<sup>23</sup> where the minimum number of cases to include is  $N=10k/p$ , with 16 covariates included in our logistic regressions and 17% and 12% of students reporting lifetime and past month vape use, the minimum sample size is 942 and 1334 students, respectively.

## Results

From a total population of 38 442 students who were invited to participate in the study, 2626 students completed the survey, representing a response rate of 6.8%. Of these 2626 students who participated in the study, 2619 responded to the question about lifetime vape use and all 2626 students reported past month vape use, if any.

**Table 2.** Sociodemographic, risk-taking behavior, and mental health differences by age category in a sample of university students (N=2626).

VARIABLES	17-19 (N=725)	20-25 (N=1405)	26+ (N=466)	P VALUE
Female (%)	77.1	75.5	72.5	.07
White (%)	53.8	64.2	66.1	<.001
No religion followed during childhood (%)	29.3	30.1	26.5	.13
No religion followed presently (%)	50.1	57.0	63.2	.01
Straight/heterosexual (%)	84.1	82.7	79.1	<.01
Raised in 2-parent family (%)	88.1	83.4	79.6	.01
Maternal college diploma or university degree (%)	78.3	74.6	60.3	<.001
Currently living on campus residence (%)	53.0	7.0	4.9	<.001
Ever vaped (%)	41.0	52.5	6.5	<.001
Past month vaping (%)	19.7	11.1	3.2	<.001
Past month alcohol (%)	76.1	79.5	77.5	.19
Past month smoking (%)	9.0	12.4	22.5	<.001
Past month cannabis (%)	36.7	41.1	35.6	.04
Past month cocaine (%)	2.9	5.9	4.9	.01
Past month LSD (%)	1.7	1.6	3.0	.12
Past month prescription drugs not prescribed (%)	5.4	6.8	9.9	.01
Number of sexual partners past month (mean, SD)	0.5 ± 0.8	0.6 ± 0.6	0.8 ± 0.7	<.001
Ever diagnosed with a mental health problem (%)	23.3	28.9	37.1	<.001
Engaged in self-harm (%)	22.3	25.6	24.4	.26
Hours of sleep per night (mean, SD)	8.5 ± 1.1	8.5 ± 1.0	8.3 ± 1.2	<.001
Hours of moderate/vigorous physical activity per week (mean, SD)	2.7 ± 2.2	2.8 ± 2.2	2.6 ± 2.1	.28

Table 2 compares differences in sociodemographic characteristics, risk-taking behavior, and mental health outcomes by age category of university students. Most students in this sample were female (17-19 years: 77.1%; 20-25 years: 75.5%; 26+ years: 72.5%;  $P=.07$ ). Teenage university students were the least likely to identify as white (53.8%) and the most likely to be raised in a 2-parent family during their childhood (88.1%) and to have a mother with either a college diploma or university degree (78.3%). Overall, 41.0% of teens had vaped in their lifetime, compared to 52.5% of students 20 to 25 years, and 6.5% of those aged 26+ years ( $P<.001$ ). About one-fifth of teens (19.7%) had vaped in the past month, compared to 11.1% of students 20 to 25 years, and only 3.2% of students 26+ years of age ( $P<.001$ ). This clear association was completely reversed for cigarette smoking, where 9.0% of teens, 12.4% of students 20 to 25 years, and 22.5% of those 26+ years had smoked in the past 30 days ( $P<.001$ ). Over one-third of all age groups reported using cannabis over the past month, with the highest

percentage being among students ages 20 to 25 years (41.1%). With respect to mental health, 23.3% of teens had been diagnosed with a mental health problem in their lifetime, compared to 28.9% of students 20 to 25 years, and 37.1% of students 26+ years ( $P<.001$ ). Most students were getting adequate sleep each night (8.3-8.5 hours), although all the age groups were getting less than 3 hours of moderate to vigorous physical activity per week.

Table 3 shows the crude and adjusted odds ratios of logistic regression models assessing the correlates of lifetime and past month vape use in university students. Compared to those ages 26+ years, teen university students were over 10 times more likely (OR: 10.57; 95% CI: 5.22, 21.38) and males were over 2 times as likely than females to have vaped in the past month (OR: 2.14; 95% CI: 1.57, 2.92). Current religion was mostly unrelated to vaping, except that Catholics were 63% more likely than other Christians to have ever vaped (OR: 1.63; 95% CI: 1.01, 2.62). Alcohol, cigarette, cannabis,

**Table 3.** Crude and adjusted odds ratios of logistic regression models assessing correlates of lifetime and past month vape use in university students (N=2626).

	VAPE USE EVER		PAST MONTH VAPE USE	
	CRUDE OR [95% CI]	ADJUSTED OR [95% CI]	CRUDE OR [95% CI]	ADJUSTED OR [95% CI]
<b>Age (years)</b>				
26+	1.00	1.00	1.00	1.00
17-19	5.03 [3.33, 7.59]	9.73 [5.37, 17.61]	7.39 [4.28, 12.75]	10.57 [5.22, 21.38]
20-25	2.99 [2.00, 4.47]	3.67 [2.15, 6.27]	3.76 [2.19, 6.45]	3.46 [1.80, 6.65]
<b>Gender</b>				
Female	1.00	1.00	1.00	1.00
Male	1.57 [1.25, 1.97]	1.64 [1.23, 2.18]	1.88 [1.46, 2.42]	2.14 [1.57, 2.92]
<b>Race/ethnicity</b>				
Non-white	1.00	1.00	1.00	1.00
White	1.33 [1.07, 1.64]	0.80 [0.60, 1.07]	1.48 [1.15, 1.91]	0.96 [0.69, 1.32]
<b>Current religion</b>				
Christian	1.00	1.00	1.00	1.00
Catholic	1.66 [1.12, 2.47]	1.63 [1.01, 2.62]	1.37 [0.85, 2.21]	1.11 [0.64, 1.92]
Hindu	0.56 [0.22, 1.46]	0.66 [0.22, 1.98]	0.50 [0.15, 1.65]	0.71 [0.19, 2.69]
Islam	0.68 [0.36, 1.29]	1.16 [0.51, 2.68]	0.86 [0.43, 1.72]	1.57 [0.65, 3.77]
Sikh	0.83 [0.24, 2.84]	0.51 [0.13, 2.00]	0.81 [0.18, 3.53]	0.46 [0.09, 2.30]
No religion	1.52 [1.12, 2.06]	1.26 [0.87, 1.84]	1.56 [1.09, 2.23]	1.18 [0.77, 1.79]
Other religion	1.43 [0.88, 2.31]	0.99 [0.55, 1.77]	1.59 [0.92, 2.74]	1.04 [0.55, 1.99]
<b>Maternal educational attainment</b>				
Some high school	1.00	1.00	1.00	1.00
High school diploma	2.72 [1.12, 6.61]	1.68 [0.61, 4.59]	2.69 [0.92, 7.88]	1.59 [0.50, 5.08]
Some college or university	3.43 [1.43, 8.22]	1.95 [0.73, 5.21]	3.54 [1.24, 10.13]	1.82 [0.59, 5.64]
College diploma or university degree	3.33 [1.44, 7.68]	2.05 [0.81, 5.23]	3.43 [1.25, 9.44]	1.86 [0.63, 5.50]
Postgraduate degree	3.71 [1.58, 8.73]	2.21 [0.85, 5.77]	3.62 [1.29, 10.16]	1.78 [0.59, 5.38]
<b>Alcohol use</b>				
No	1.00	1.00	1.00	1.00
Yes	7.64 [4.78, 12.22]	2.71 [1.57, 4.66]	5.90 [3.54, 9.84]	2.02 [1.11, 3.66]
<b>Smoked cigarettes</b>				
No	1.00	1.00	1.00	1.00
Yes	6.95 [5.42, 8.90]	4.92 [3.53, 6.85]	4.97 [3.80, 6.51]	2.77 [1.94, 3.94]
<b>Cannabis use</b>				
No	1.00	1.00	1.00	1.00
Yes	7.30 [5.76, 9.25]	4.16 [3.13, 5.53]	6.11 [4.66, 8.02]	3.18 [2.30, 4.40]
<b>Cocaine use</b>				
No	1.00	1.00	1.00	1.00

(Continued)

Table 3. (Continued)

	VAPE USE EVER		PAST MONTH VAPE USE	
	CRUDE OR [95% CI]	ADJUSTED OR [95% CI]	CRUDE OR [95% CI]	ADJUSTED OR [95% CI]
Yes	7.77 [5.33, 11.32]	2.53 [1.54, 4.17]	8.09 [5.54, 11.83]	3.28 [1.99, 5.41]
LSD use				
No	1.00	1.00	1.00	1.00
Yes	4.61 [2.50, 8.53]	0.89 [0.40, 2.00]	3.40 [1.75, 6.61]	0.76 [0.32, 1.79]
Prescription drugs				
No	1.00	1.00	1.00	1.00
Yes	4.31 [3.12, 5.95]	1.87 [1.22, 2.89]	3.24 [2.26, 4.63]	1.12 [0.69, 1.80]
Number of sexual partners				
0	1.00	1.00	1.00	1.00
1-5	1.82 [1.36, 2.43]	1.13 [0.80, 1.61]	2.42 [1.65, 3.54]	1.83 [1.19, 2.82]
6-10	3.06 [2.13, 4.40]	1.48 [0.93, 2.34]	4.28 [2.73, 6.70]	2.90 [1.69, 4.96]
11-15	3.02 [1.96, 4.65]	1.00 [0.56, 1.78]	5.22 [3.16, 8.62]	3.04 [1.62, 5.73]
16+	4.88 [3.26, 7.31]	2.01 [1.15, 3.52]	7.25 [4.50, 11.69]	4.72 [2.54, 8.77]
Diagnosed mental illness				
No	1.00	1.00	1.00	1.00
Yes	1.45 [1.17, 1.80]	1.10 [0.83, 1.48]	1.27 [0.99, 1.64]	0.88 [0.64, 1.23]
Self-harm				
No	1.00	1.00	1.00	1.00
Yes	1.60 [1.28, 2.01]	1.16 [0.86, 1.56]	1.86 [1.45, 2.39]	1.65 [1.19, 2.29]
Current living arrangement				
Off campus, with common-law partner/spouse	1.00	1.00	1.00	1.00
Campus residence	4.37 [2.53, 7.57]	2.53 [1.23, 5.19]	9.62 [4.15, 22.29]	5.77 [2.19, 15.23]
Off campus, living alone	2.08 [1.08, 4.00]	1.83 [0.86, 3.93]	3.33 [1.27, 8.71]	2.79 [0.98, 7.94]
Off campus with roommates	4.31 [2.55, 7.27]	2.79 [1.45, 5.36]	7.78 [3.41, 17.75]	4.66 [1.86, 11.66]
Off campus with parents	2.75 [1.55, 4.88]	2.56 [1.26, 5.20]	4.79 [2.00, 11.46]	4.09 [1.55, 10.83]
Sleep duration per night	1.17 [1.07, 1.29]	1.04 [0.93, 1.17]	1.18 [1.06, 1.32]	1.05 [0.92, 1.19]
Constant	-7.46		-8.58	
Adjusted $R^2$	.38		.34	

and cocaine use were all highly associated with lifetime and past month vape use. Lifetime alcohol use doubled the risk of vaping in the past 30 days, whereas lifetime cigarette, cannabis, or cocaine use approximately tripled the odds of vaping in the past month. Compared to university students who have never had sex, those who reported having 16+ sexual partners were 2 times more likely to have ever vaped (OR: 2.01; 95% CI: 1.15, 3.52) and almost 5 times more likely to have vaped in the past month (OR: 4.72; 95% CI: 2.54, 8.77). Students who had reported engaging in self-harm were 65% more

likely to have vaped in the past month than students who had never tried to harm themselves (OR: 1.65, 95% CI: 1.19, 2.29). Lastly, compared to students living off campus with a common-law partner/spouse, students living on campus residence, off campus with roommates, and off campus with parents were between 4 and almost 6 times more likely to have vaped in the past month. Overall, 38% of the variance in lifetime vape use and 34% of the variance in past month vape use can be accounted for by the independent variables in the regression equations.

**Table 4.** Crude and adjusted odds ratios of logistic regression models predicting lifetime and past month vape use among university students who are not of legal age (17-18 years) to purchase vaping products in Ontario (N=390).

	VAPE USE EVER		PAST MONTH VAPE USE	
	CRUDE OR [95% CI]	ADJUSTED OR [95% CI]	CRUDE OR [95% CI]	ADJUSTED OR [95% CI]
<b>Gender</b>				
Female	1.00	1.00	1.00	1.00
Male	1.25 [0.75, 2.08]	1.53 [0.81, 2.88]	1.36 [0.80, 2.33]	1.59 [0.82, 3.10]
<b>Race/ethnicity</b>				
Non-white	1.00	1.00	1.00	1.00
White	1.84 [1.17, 2.91]	1.07 [0.61, 1.88]	2.37 [1.43, 3.91]	1.48 [0.81, 2.72]
Raised in a single parent family	1.77 [1.03, 3.03]	1.22 [0.61, 2.45]	1.83 [1.04, 3.23]	1.18 [0.57, 2.45]
<b>Alcohol use</b>				
No	1.00	1.00	1.00	1.00
Yes	8.87 [3.76, 20.96]	3.38 [1.31, 8.75]	6.47 [2.73, 15.35]	1.98 [0.74, 5.30]
<b>Smoked cigarettes</b>				
No	1.00	1.00	1.00	1.00
Yes	12.06 [4.71, 30.88]	3.94 [1.40, 11.11]	9.08 [3.90, 21.11]	3.02 [1.14, 8.06]
<b>Cannabis use</b>				
No	1.00	1.00	1.00	1.00
Yes	7.04 [4.28, 11.57]	3.25 [1.79, 5.90]	6.46 [3.81, 10.97]	2.78 [1.45, 5.33]
<b>Cocaine use</b>				
No	1.00	1.00	1.00	1.00
Yes	14.39 [1.66, 124.67]	4.85 [0.48, 49.04]	19.05 [2.19, 165.40]	5.99 [0.61, 58.80]
<b>Prescription drugs</b>				
No	1.00	1.00	1.00	1.00
Yes	4.44 [1.54, 12.79]	2.56 [0.71, 9.24]	4.45 [1.57, 12.66]	2.58 [0.74, 8.99]
<b>Number of sexual partners</b>				
0	1.00	1.00	1.00	1.00
1-5	3.81 [2.25, 6.45]	1.67 [0.90, 3.10]	5.53 [2.94, 10.40]	2.55 [1.26, 5.18]
6-10	7.15 [2.74, 18.64]	2.31 [0.74, 7.18]	13.04 [4.73, 36.00]	4.75 [1.47, 15.31]
11-15	6.50 [1.24, 34.08]	1.31 [0.22, 8.02]	11.86 [2.19, 64.31]	2.59 [0.40, 16.83]
16+	1.63 [0.17, 15.16]	0.84 [0.08, 8.87]	2.96 [0.31, 28.36]	1.54 [0.15, 15.85]
<b>Self-harm</b>				
No	1.00	1.00	1.00	1.00
Yes	1.44 [0.85, 2.46]	0.95 [0.50, 1.82]	1.92 [1.11, 3.33]	1.37 [0.70, 2.66]
Constant	-3.210		-3.609	
Adjusted R <sup>2</sup>	.33		.33	

For the secondary objective, 14.9% of the total sample (390/2626) were 17 to 18 years of age. Of this subsample, 26.7% had ever vaped in their lifetime and 21.8% had vaped in

the past month. Table 4 provides logistic regression models for correlates of lifetime and past month vape use among university students who are not of legal age (ie, <19 years) to



purchase vaping products in Ontario. In the adjusted model for lifetime vape use, only past substance use was correlated with ever having vaped. Students who reported alcohol (OR: 3.38, 95% CI: 1.31, 8.75) and cannabis use (OR: 3.25; 95% CI: 1.79, 5.90) were over 3 times more likely to have ever vaped and those who reported smoking cigarettes were almost 4 times more likely to have vaped (OR: 3.94; 95% CI: 1.40, 11.11) than those who had never used these substances. Like the association between substance use and ever vape use, cigarette smoking and cannabis use were correlated with past month vape use. Students who smoked cigarettes were 3 times more likely to have vaped in the past 30 days than those who had never smoked (OR: 3.02; 95% CI: 1.14, 8.06), and cannabis use was also associated with an almost threefold increase in past month vape use (OR: 2.78, 95% CI: 1.45, 5.33). Compared to students who reported never having sex, those who reported having 1 to 5 sexual partners were 2.6 times more likely to have vaped in the past month (OR: 2.55; 95% CI: 1.26, 5.18) and those who had 6 to 10 sexual partners were almost 5 times more likely to have vaped in the past month (OR: 4.75; 95% CI: 1.47, 15.31). Overall, 33% of lifetime and past month vape use could be explained by the independent variables in the models.

## Discussion

This study adds to the limited research on vape use in Canadian post-secondary students. We found that, while vaping is common among all university students, it is particularly high among the youngest students. Indeed, 41.0% of teenage students had self-reported vaping in their lifetime and one-fifth (19.7%) of them have vaped in the past month. These rates are comparable to Ontario data from 2019, where 23% of students in grades 7 to 12 had vaped in the past year and 33% of students in grade 12 had vaped in the past 12 months.<sup>3</sup> Other top risk factors for lifetime and past month vape use in the current study included male gender, alcohol, cigarette, cannabis, and cocaine use, and having many (16+) sexual partners.

Our finding that males were more likely to vape than females is in keeping with research from college students in the U.S.<sup>10-12</sup> This result may not be surprising, given that males are also more likely to smoke cigarettes<sup>24</sup> and experience greater subjective reward from nicotine than do females.<sup>25</sup> Research also suggests that, unlike cigarette smoking, vaping advertisements tend to focus predominantly on males,<sup>26</sup> which likely contributes to their higher use in males. Additionally, we found that past and current vape use was highly correlated with alcohol, cannabis, cocaine, and tobacco use. Cigarette smoking has also been shown to be a top predictor of vape use in college students in the U.S.<sup>10-12</sup> and Europe<sup>13,14</sup> and past and current vape users were more likely than non-vapers to use alcohol, cannabis, and cocaine in U.S. college students.<sup>27</sup> Our findings also coincide with data from the 2017 Canadian Tobacco, Alcohol and Drugs Survey, where a strong association was found between vaping and cannabis, alcohol, and illicit drug

use among Canadians aged 15 to 24 years.<sup>28</sup> However, unlike the nationally representative Canadian data, our findings show a much higher prevalence of current vape use among university students. Whereas 6.2% of Canadians aged 15 to 24 years had self-reported vaping in the past month,<sup>28</sup> we found that 19.7% of teens and 11.1% of students 20 to 25 years had vaped in the past month. The higher prevalence of vape use in the current study, which is based on more recent data, is at least partially attributable to the growing popularity and use of vapes in the past few years.<sup>3</sup> It is also plausible that high risk-taking behavior, that is characteristic of university students,<sup>6,7</sup> may also explain some of the variation in vape use in this study. Lastly, compared to university students who had never had sex, those with 16+ partners were far more likely to have ever vaped in their lifetime and in the past month. Although research examining this relationship is limited, especially in post-secondary students, this finding has been shown in adolescent populations. A nationally representative study of high school students in the U.S. found that vape users were more likely than nonusers to have  $\geq 4$  sexual partners in their lifetime and to be currently sexually active.<sup>29</sup> Similarly, in the Healthy Kids Colorado Survey, middle school and high school students who were current vapers were more likely than nonusers to have had more than 1 sexual partner in the last 3 months.<sup>30</sup>

When the regression analysis was limited to university students who were not of legal age to purchase vaping products in Ontario (ie, 17-18 years), only cigarette smoking and cannabis use remained correlated with both lifetime and past month vape use. However, the correlations remained similar to the full sample. For example, alcohol use was highly and significantly correlated with lifetime vape use. Similarly, although not statistically significant, the odds of vape use (both lifetime and past month) were higher for males than females, and for those who used cocaine compared to those who did not, but the wide confidence intervals reflect the smaller sample size and lower statistical power of the secondary analysis. Further exploration of these correlations with larger samples of younger teenagers are needed in future research. While the relationship between vape use and cigarette smoking is well established,<sup>31,32</sup> recent evidence suggests that poly-substance use is increasing among youth and that vaping has played a key role at increasing it.<sup>33</sup> In a systematic review and meta-analysis, vaping has also been found to be significantly associated with cannabis use.<sup>34</sup>

There are 3 limitations that should be considered when interpreting the results of this study. The first is that the data were captured cross-sectionally, meaning that associations between potential risk factors and vape use were measured at 1 point in time. However, to increase our confidence in the proper time order, we used past month vape use as one of our dependent variables and many of our independent variables were fixed at some point prior to variation in the dependent variable (eg, age, race, sex, childhood family structure,

maternal education). Nonetheless, given the cross-sectional nature of the survey, we are only able to assess correlates of vape use in university students and could not investigate causal relationships. Second, our findings on correlates of vape use in university students cannot be generalized to post-secondary students across Canada as data were limited to a single university in London, Ontario. Additionally, 75% of our sample consisted of females, which is considerably higher than what is representative of the Western University student population at 56%.<sup>35</sup> While this may have resulted in a biased sample, limiting the extent to which conclusions can be drawn from the data, our findings with respect to gender and vape use coincide with other studies on this topic. Our large sample of female university students may not also be that surprising, as a recent survey of undergraduate students at Western University consisted of 74% females.<sup>36</sup> Third, our response rate of 6.8% was low and may limit the reliability of the results. We cannot also rule out self-selection bias, whereby students more interested in the topic of risk-taking behaviors were the ones more likely to complete the survey. However, research suggests that response rate bias is more concerning in univariate analyses of demographic characteristics and behaviors, but when assessing associations between variables using multivariate analysis, there is little evidence of bias from low response rates for most outcome variables.<sup>37</sup>

Our study adds to the limited research on vape use among post-secondary students in Canada. Findings from this research suggest that lifetime and past month vape use is far more common among teenage university students, males, those who drink alcohol, smoke, use cannabis or cocaine, and who have a history of many sexual partners. Among those who are not of legal age to purchase vaping products in Ontario (ie, students 17-18 years), vaping is highly correlated with cigarette smoking and cannabis use. It is hoped that these findings can be used by the university and local public health unit to develop future vaping awareness and prevention campaigns and to effectively target such activities to the most vulnerable students. Future research should expand these findings to other post-secondary institutions across Canada and utilize longitudinal designs to determine which risk factors increase the likelihood of first time vape use or vaping on a more regular and frequent basis. Such studies can provide public health policymakers and decisionmakers with the additional evidence they need to develop policies and programs aimed at curbing vape use among Canadian youth.

### Author Contributions

JAS wrote the manuscript, designed the study, and was responsible for data collection and statistical analysis. JT co-designed the study and revised and contributed to the writing of the manuscript. JAG revised and contributed to the writing of the manuscript.

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